
BIOFUEL CHAIN: DEVELOPMENT, COMPETITIVENESS AND SUSTAINABILITY IN BRAZIL¹

M.Sc. Ana Cecília Kreter²

Fluminense Federal University (UFF) and Center for Agricultural Policy (NPA)
Münsterstr. 18
40477 Düsseldorf, Germany
Phone: +49 163 842 6445

Annyeli Nascimento³

Rio de Janeiro State University (UERJ) and Center for Agricultural Policy (NPA)

Dr. Antonella Samoggia⁴

University of Bologna

Dr. Gervásio Castro de Rezende⁵

Fluminense Federal University (UFF) and Center for Agricultural Policy (NPA)

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² PhD Student in Economics at the Fluminense Federal University (UFF), and Research Manager of the Center for Agricultural Policy (NPA). Mailto: kreter@npa.agr.br

³ Undergraduate Student in Economics at the Rio de Janeiro State University (UERJ), and Communications Manager of the Center for Agricultural Policy (NPA). Mailto: nascimento@npa.agr.br

⁴ Professor at the University of Bologna. Mailto: antonella.samoggia@unibo.it

⁵ Professor at the Fluminense Federal University (UFF), and Coordinator of the Center for Agricultural Policy (NPA). Mailto: gcrezende@terra.com.br

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Abstract

The purpose of this paper is to analyze the Brazilian biofuel chain, according to the Porter's competitive advantage approach. The Brazilian biofuel policy is worldwide known not only by stimulating its production, but also by granting tax incentives. The current paper highlights how the biofuel policy was developed in Brazil since the adoption of *Proálcool*, how this chain works, and how the government coordinates the different production stages. Despite Brazil had gone by different phases, from the full adoption and support by the federal government to the low public incentives, most of the mills kept the productive structure of *Proálcool*.

The results of this study show that the government participation is crucial for the success of the biofuel program. In addition, unlike other nations, Brazil still has the possibility to increase his production – either through harvest area or through productivity – without environmental damage. Thus, Brazil could increase its exportation, with relative competitive advantage. Finally, the study results show that, in a medium-term, the biofuel exportation growth cannot affect fuel prices in domestic market, which is another competitive advantage in international market.

1. Introduction

The new decisions of the Organization of the Petroleum Exporting Countries (OPEC) and the up-rise in petroleum prices since 2007 have stimulated many countries to design new programs of biofuel as a substitute for gas. The rapid development of the biofuel's industry is currently posing some questions related to the different agents of this chain. The emerged international scenario takes us to the 1970's, when the Brazilian government was pioneer and adopted the first biofuel program (called *Proálcool*). Since then, Brazil went by different phases, from the full adoption and support by the federal government to the low public incentives. Nowadays, Brazil still stands out at the international market. The Brazilian policy is worldwide known not only by stimulating the biofuel production, but also by granting tax incentives. As a result, most vehicles sold in domestic market have *flexfuel* motor.

The purpose of this paper is to analyze the Brazilian biofuel chain, focusing on its development, competitiveness and sustainability. The methodology chosen in this study is the competitive advantage approach based on the four sets of Porter's *national diamond*.

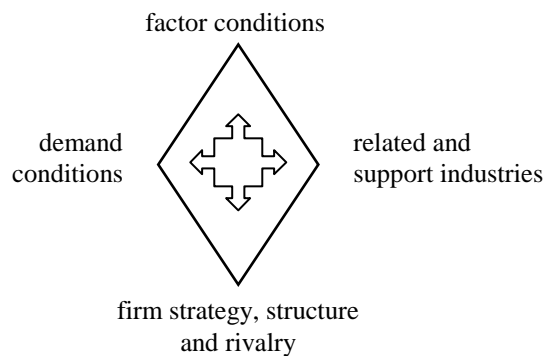
This paper has five sections, including this introduction. The next section starts by presenting the Porter's theory, stressing the most important features that a production chain should have to reach success at the market. Section three deepens the discussion of the Brazilian biofuel chain. In particular, this section highlights how the biofuel policy was developed in Brazil since the adoption of *Proálcool*, how this chain works, and how the federal government coordinates the different production stages, not only the supply, but also the demand. Section four extends the analysis of the biofuel chain, applying the Porter's *national diamond* for the Brazilian case. Finally, section five presents the main conclusions of the paper.

2. Methodological Approach

Porter starts his analysis about the national influences on competitive advantage, from the following questions: "Why are certain companies based in certain nations capable of consistent innovation? Why do they ruthlessly pursue improvements, seeking an evermore sophisticated source of competitive advantage? Why are they able to overcome the substantial barriers to change and innovation that so often

accompany success?” (Cho & Moon, 2000). The answer lies in a set of variables called Porter’s *national diamond*. As a diamond, the Porter’s theory is based on four pillars: factor conditions, demand conditions, related and support industries, and firm strategy, structure and rivalry (Figure 1). Porter also considers the government and the chance events as important variables to influence the competitive advantage.

Figure 1
Porter’s *National Diamond*



Source: Porter (1990). Elaborated by the authors.

The theory of competitive strategy broaches the impact of national environment on international performance. Therefore, according to Porter (1990), firms rather than nations are the principal actors, and the four sets from Figure 1 operate interdependently rather than individually. These characteristics compose the competitive advantages of a nation and are presented below.

The factor conditions are related to the factors of production. Porter divides them in two main groups: *a)* basic factors; and *b)* advanced factors. The first one includes factors that are already done, such as natural resources, climate, demographic, unskilled and semiskilled labor, and debt capital. The second group includes factors that were developed by individuals, companies or nations, such as modern communications infrastructure, new technologies, sophisticated employee skills, such as high educated personnel, design capabilities, and research facilities (Grant, 1991).

Porter stresses the importance of the relationship between basic and advanced factors, although he considers this relationship complex. For example, the basic factors are more relevant for the first decision of a firm – where it should be located, for example. After that, the advanced factors become the most significant for competitive advantages. It does not mean that natural resources do not play an important role to firms’ performance. But in the Porter’s theory firms’ investments, and advanced factors in general, are crucial for the *demand conditions* because they should prioritize the domestic market.

According to Porter (1990), firms have to understand the features of the national environment before an investment’s decision. Under this consideration, some variables are significant to help a decision, such as purchasing power, education index, and national economic stability. The rate of growth of domestic demand rather than its absolute size is more important to competitive advantage. As Grant (1991) stresses, “firms are typically most sensitive to the needs of their closest customers, hence the characteristics of home demand are particularly important in shaping the differentiation attributes of domestically-made products and in creating pressures for innovation and quality”. But, since this demand is attended, the international market is a goal for new upgrading.

The third set of Porter’s *national diamond* is *supporting industries* by which firms coordinate or share activities in the value chain. It can also be connected to firms which involve products that are

complementary to the firms of a given nation (Cho & Moon, 2000). These successful industries are usually grouped into clusters. Some features are fundamental to reach this status: high geographic firms' concentration, existence of all types of support institutions related to the cluster's product, highly specialized firms, each of them performing a few tasks, presence of some firms with the same tasks, and large cooperation between local firms. Moreover these firms have linkage with each other as a strong production chain, contemplating different production stages.

Last in the Porter's theory but not least in importance are *firms' strategy, structure and rivalry*. Although Porter argues that there is no universal managerial system, he recognizes that some characteristics impact on a nation's competitiveness. These characteristics can be summarized as follows: organization, strategy, structure, goals and management. Nevertheless, as at the *demand conditions*, this set emphasizes the domestic market, specifically the domestic rivalry, for creating and sustaining competitive advantage. As Grant (1991) pointed out, "rivalry is critically important in pressuring firms to cut costs, improve quality, and innovate". But Porter argues that these improvements are more effective if the domestic rivalry is superior to rivalry with foreign competitors. The reason is quite simple: if firms compete from a common national market, the competition is more emotive and personal. Hence, at the Porter's theory, foreigners are treated unequally as compared to domestic citizens.

In final analysis, Porter supports that the interdependence between these four sets from Figure 1 create some complex dynamics. The intensity of interaction depends on two features: clustering and geographical location. It means that not only the vertical linkage firms' proximity is important to push structural upgrading for the national competitive performance, but also the proximity of rival firms. However, he pointed out some notable exceptions in Asia, where the firms focus on the world market instead of the national market. Thus, these exceptions are also examples of success, because the domestic demand, which has no significance, is offset by the international demand. Note that the singularity from nation to nation can be considered according to the importance of each set. Prior to analyze the Brazilian biofuel chain based on the Porter's *national diamond*, the paper presents an overview of this sector.

3. The Brazilian Biofuel Chain

The biofuel technology started in Brazil during the 1970's, when the government decided to add anhydrous alcohol to gas as a response of the first international oil crisis. On account of that, Brazil became pioneer in using renewable raw material to produce energy. Since then, the Brazilian biofuel production went through different phases. This section analyses current biofuel programme and biofuel chain in Brazil.

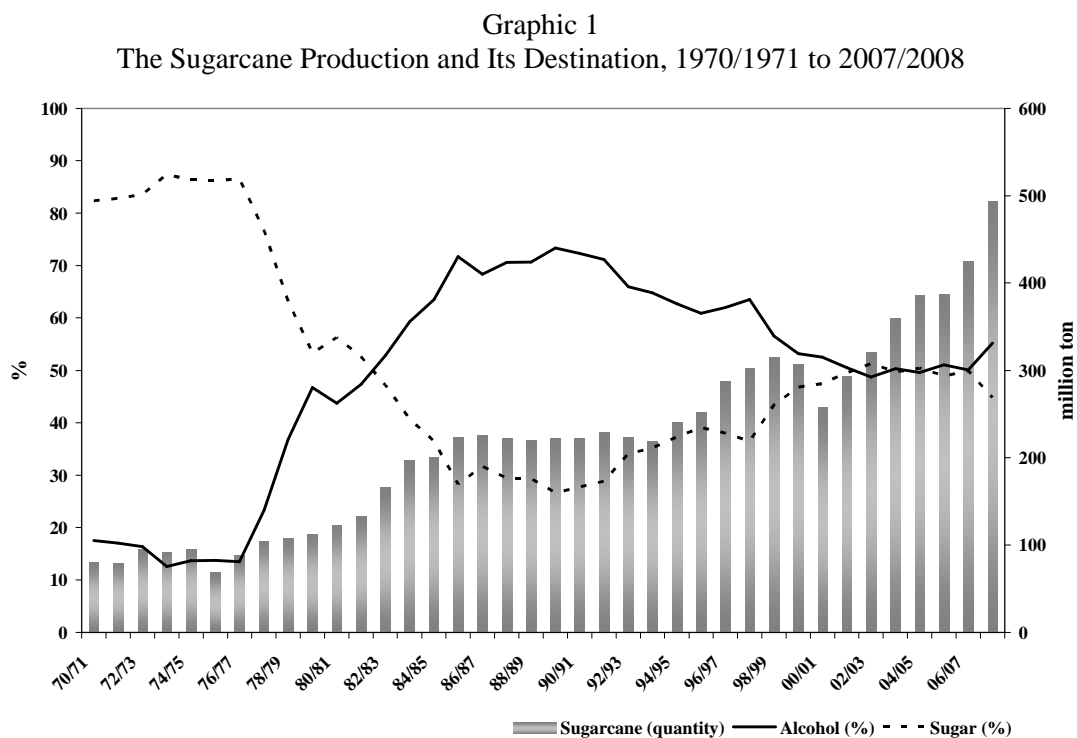
3.1. The Biofuel Policy

In 1975 the Brazilian government adopted the first biofuel programme as a substitute for gas, the *Proálcool*.⁶ At this time, the main motivation to develop such technology was the rise of oil price in 1973 and the international uncertainty on the energy supply during the following years. Although this enactment has given permission to use different kinds of raw material to produce biofuel – sugarcane, manioc, etc. – the General-Command of Aerospace Technology (CTA), responsible for the research and development (R&D), decided to use sugarcane because of large domestic production, low production's costs, and, at this time, low sugar price. The Brazilian government, in partnership with the World Bank, set a schedule which included two main stages. The first one was to modernize and to expand the current facilities, increasing the alcohol production.⁷ Until 1978 the government used alcohol exclusively for a mixture with gas. The percentage used for that varied from year to year (see Annex I). The results came quickly. From 1975 to 1976 the alcohol production increased almost five times, reaching 3.4 billion liters per year. Graphic 1 presents the sugarcane production in Brazil and its destination – alcohol or sugar.

⁶ Enactment nº 76593, of November 14th 1975.

⁷ We use *alcohol* as a general concept, but it has two concentrations of alcohol: anhydrous alcohol, which is mixed with gas, and hydrous alcohol, which is used as a substitute for gas.

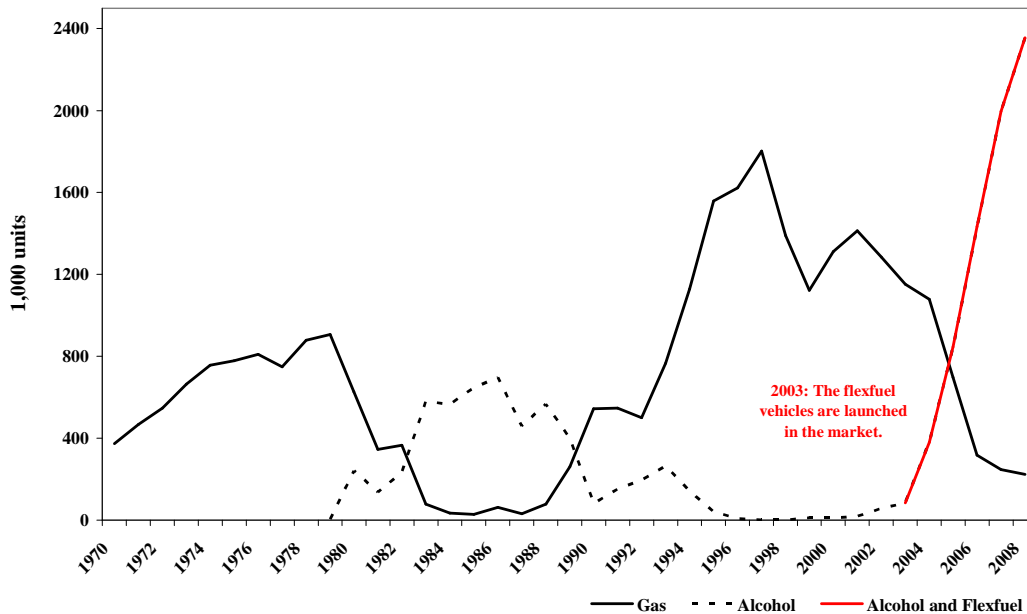
According to Graphic 1, since the adoption of *Proálcool*, the sugarcane production was targeted for the supply of alcohol. It is clear that from 1975 the production of sugar has been replaced by production of alcohol. However, the sugarcane production reached new records year by year, which means that both products had increased in the quantity produced.



Source: DATAGRO (2009) and UNICA (2009). Elaborated by the authors.

In 1978 the Chrysler Group launched in the market the first car, whose consumption was 100% alcohol – the Dodge 1800. To develop a new motor's technology was the second stage of the government's schedule. From this year on, cars with alcohol motor became more and more popular, especially on account of oil price increase after the second oil crisis. This preference can be noted in the number of vehicles sold with both technologies (Graphic 2).

Graphic 2
Number of Vehicles* Sold in Brazil, 1970 to 2008



Source: ANFAVEA (2009). Elaborated by the authors.

* It corresponds to cars and light commercial vehicles.

Note that during the 1980's the vehicles with alcohol motor became the most important in the Brazilian market, remaining at the first position until 1990. Despite the return of alcohol motor was lower than the gas motor, oil prices compensated the use of the new technology.⁸ The vehicle's production stayed on until 1988, when the government reduced dramatically the public resources destined to this sector. The drop in sales from 1988 can be seen in Graphic 2. Nevertheless, the situation got worse when the oil price decreased and the sugar price increased in international market. The period between 1986 and 1995 was called *counter oil crisis*. Thus, not only the consumer, but also the producers decided to return to gas. And, because of that, the alcohol production hit the lowest levels. In the beginning of the 1990's, it became hard to find alcohol at the gas stations, as well as vehicles with alcohol motor. The *Proálcool* program was left behind.

The Brazilian government restarted the biofuel policy in 2002, when he reduced the *Tax on Industrialized Products* (IPI) for biofuel vehicles.⁹ This policy stimulated the industrial sector, which brought to the market the first national flexfuel vehicle eight months later – Gol Total Flex by Volkswagen and Corsa Flex Power by General Motors.¹⁰ For the consumers, it meant not only cheaper vehicles at the market, but also the possibility to fuel them with alcohol (hydrous), gas (with 25% of anhydrous alcohol) or any mixture of them. Furthermore, in 2008, the government extended the number of installments for payment up to 90 months, often without charge to purchase. The result was an explosion in sales of vehicles never seen before in Brazil. Graphic 2 shows it clearly. Since then, almost all industries installed in Brazil produce flexfuel vehicles. Nowadays, just six years after the launch of the first flexfuel vehicle, this technology already represents 85% of all new vehicles sold inside the country, with a growth of 173% per year (ANFAVEA, 2009), featuring Brazilian at the forefront of the so-called *green fuel*.

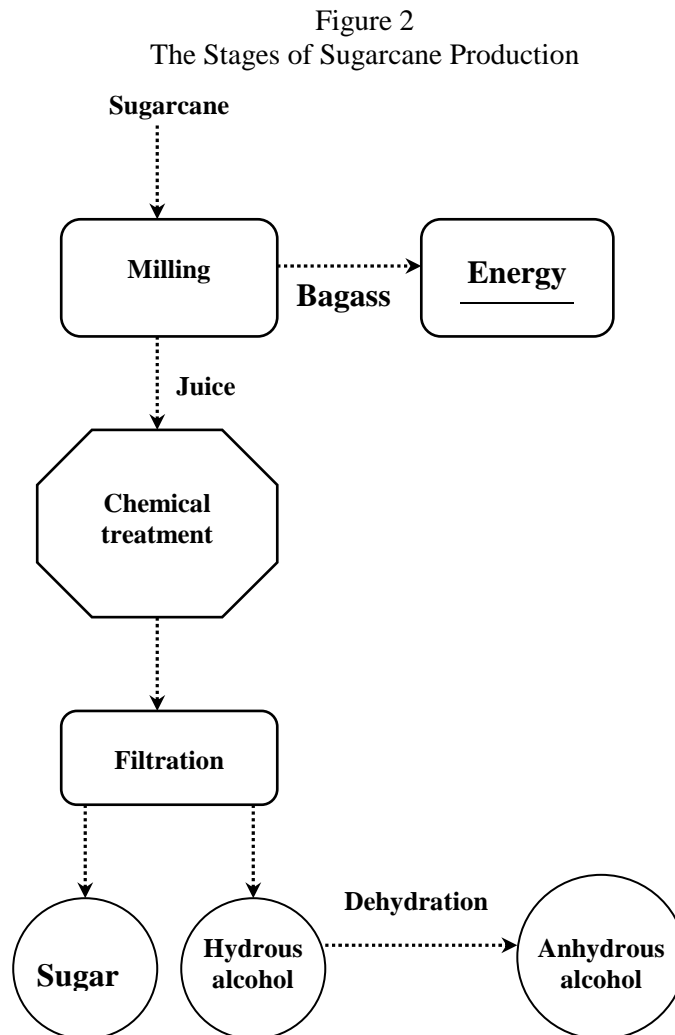
⁸ It is known that if the alcohol's price is lower than 70% of the gas' price, then it is profitable to consume alcohol instead of gas.

⁹ Enactment nº 4317, of July 31st 2002.

¹⁰ Despite the Brazilian pioneering, the flexfuel technology was developed in the United States. Nonetheless, this technology did not become popular there.

3.2. The Biofuel Chain

The biofuel chain is characterized by high concentration in the stages of production. The mills are responsible of them, which start with the sugarcane plantation and finish with the final product – sugar, anhydrous alcohol and hydrous alcohol– according to Figure 2. Note that the stages for biofuel production are basically the same as for sugar production.

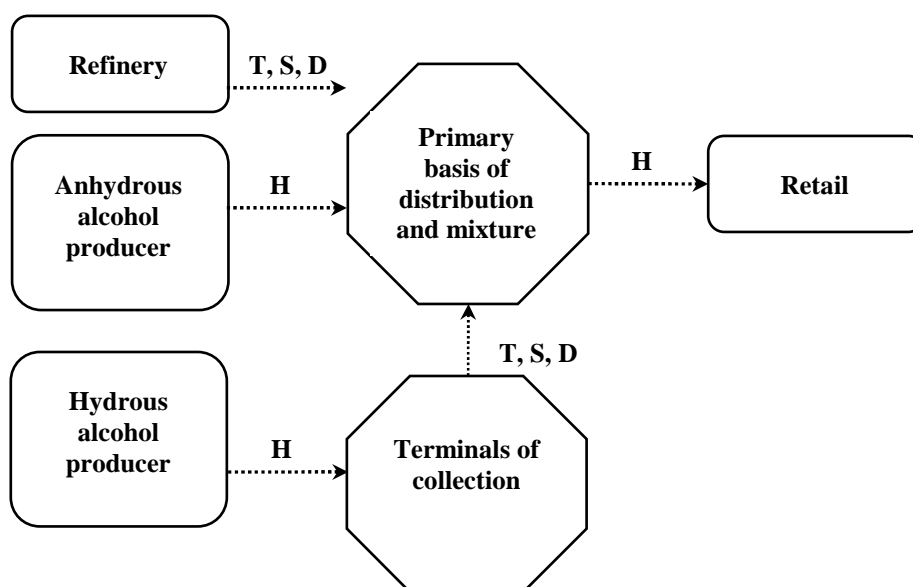


Source: BNDES & CGEE (2008).

This coordination is important to ensure that, after harvesting, the sugarcane will be taken as soon as possible to the mill. For manually collected sugarcane, the storage has to last a few days. For mechanically harvested, the storage period decreases for only several hours, because the sugarcane is chopped. If it happens, there is a loss of saccharose and, consequently, a decrease of productivity. At the first stage presented in Figure 2, the saccharose (juice) is separated from the bagasse (fiber), which is used in the mill as energy. Then, the juice is chemically treated and filtrated. From the filtration process on, the juice can be used for the production of sugar or hydrous alcohol. Observe that the anhydrous alcohol is produced from the hydrous alcohol. The possibility of using sugarcane exclusively or non-exclusively to produce biofuel represents a significant adaptation technology in this industry, which the mills can focus on a cost-effective production, depending on some market perspectives (BNDES & CGEE, 2008).

When the final product is already done – hydrous alcohol or anhydrous alcohol – the logistic of biofuel starts (Figure 3). It is interesting to understand how to storage and to transport the biofuel in Brazil, which represents nearly two million cubic meters every month, departing from more than 350 production units (BNDES & CGEE, 2008). In the national biofuel system, there are nine terminals of collection in the main producing regions (states of São Paulo, Goiás, Paraná, and Sergipe), with a total storage capacity of ninety thousand cubic meters in each one.

Figure 3
The Logistic of Biofuel Chain in Brazil



Types of Transportation: H = by Highway, T = by Train, S = by Ship, D = by Duct

Source: BNDES & CGEE (2008).

According to Figure 3, the biofuel produced is transported by highway to the terminals of collection.¹¹ If the producer is located in remote regions or in minor markets, the production is transported directly to the primary basis. In all cases, the alcohol anhydrous has to pass through the primary basis to be mixed with gas, an exclusive responsibility of fuel distributors. The Brazilian government granted it to simplify tax collection, but the quality coordination plays an important role for the success of the biofuel program. Note that in different stages it is possible to transport biofuel not only by highway, but also by train, ship or duct. Hydrous alcohol and gas mixed with anhydrous alcohol are transferred to the retail stations, which in Brazil represents almost 35.000 stations (BNDES & CGEE, 2008).

The Brazilian government counts on the regulation and supervision support of the National Agency of Petroleum (ANP). The government also counts on the Petrobras, which is currently the largest industry in this sector in the country, with the largest distribution network for fuel (BR Distributor). Because of that, Petrobras is the main fuel purchaser in Brazil, playing a strategic role for setting gas and biofuel prices for consumers. In the next section we analyze the Brazilian biofuel chain, according to the Porter's *national diamond*.

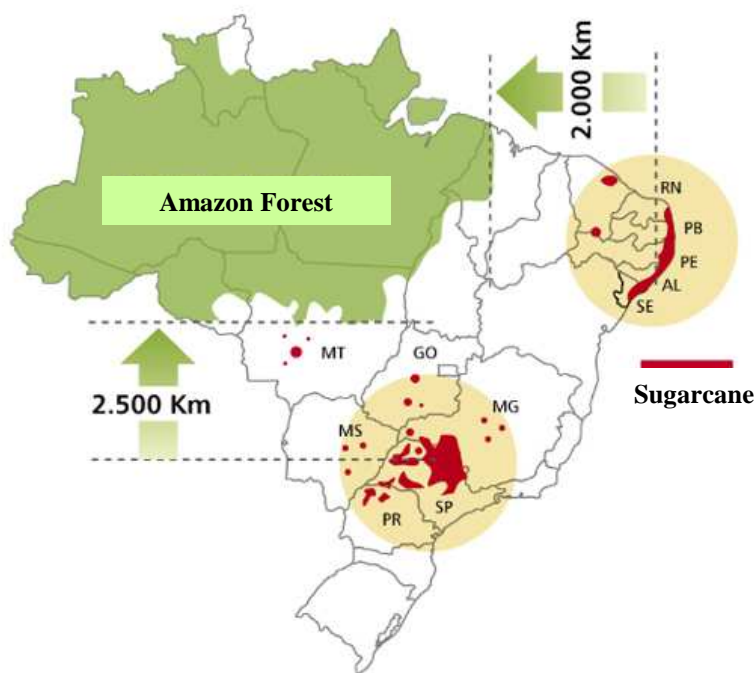
¹¹ Regarding to the gas production, the product is transported directly from the refineries to the primary basis.

4. Empirical Results of the Porter's Diamond for the Brazilian Biofuel Chain

As Porter pointed out, the factor conditions are divided in basic and in advanced factors. At the biofuel production in Brazil, both of them were (and still are) important for the program success. Among the basic factors, climate, topography, land fertility and labor are the main factors in Brazil. The tropical climate is characterized by two distinct seasons: *a)* hot and humid, to provide the germination and the growth of sprouts; and *b)* cold and dry, to promote the maturation and accumulation of saccharose (BNDES & CGEE, 2008). This climate comes about in alternating between North-Northeast (from August to April) and Center-South (from April to December), which decreases the loss of production's risk and ensures sugar and biofuel stocks during the whole year.

The harvesting of sugarcane is adaptable to the topography of the land. In flat lands, the harvest is done mechanically. In areas where the slope exceeds 30 degrees, the producers employ labor to perform this task. Brazil is one of the few countries that still has labor surplus available to be hired during the harvest. Therefore, the low production costs increase the highly competitive performance.¹² Moreover, Brazil does not have to occupy areas of environmental protection, such as the rain forest, to expand the sugarcane production capacity (see Map 1).

Map 1
Sugarcane Production Areas in Brazil and the Rain Forest



Source: NIPE, IBGE and CTC.

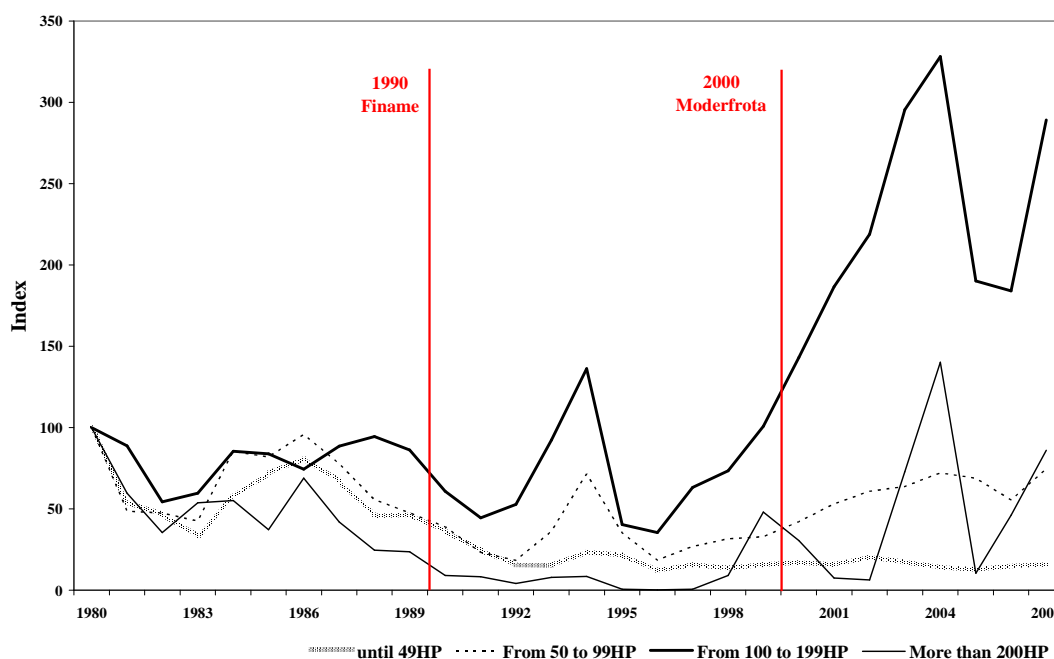
Although it is known that the sugarcane production has expanded to Central-East region in recent years, as shown in Map 1, it is still possible to reallocate degraded pastures, quite common there, in areas of high productivity. Overall, high productivity levels are also feasible occupying former rural areas and improving technology. As Azar & Larson (2009) and Johansson & Azar (2007) pointed out, the new investments tend to expand to lands close to the current production, such as the states around São Paulo

¹² This is a controversial issue, because the low wages usually paid in this sector, especially for harvesting, are recurrent points of criticism, being associated with high levels of poverty in rural areas.

and close to the coast of Northeast. Unlike other countries, in Brazil biofuel production does not compete with food production. These characteristics lead the country to the advanced factors, which are crucial to the success of the production chain.

Since the adoption of *Próalcool*, the R&D departments are committed to develop new technologies, supported by the federal government in partnership with local mills and distilleries. At the national level, there is the Brazilian Agricultural Research Corporation (EMBRAPA), which was responsible for improving the soil quality in dry areas, like in Cerrado region. Some state governments also invest in R&D. São Paulo, for example, has the Agronomic Institute of Campinas (IAC) and the “Luiz de Queiroz” College of Agriculture (ESALQ). The most important results to increase the productivity are related to programs for genetic improvement of sugarcane, such as greater resistance to pests and diseases, expansion of the crop period from six to eight months, and increase of saccharose concentration for seedling. Indeed, the Center-South region holds the highest productivity, concentrating more than 87% of the national production of milled sugarcane – 69% only in the state of São Paulo (UNICA, 2009). At the same time, the tractor industries developed new machines and launched them in the market. This feature can be observed at Graphic 3, which shows the annual rate of change of tractors, sold by power.

Graphic 3
Annual Rate of Change of Tractors Sold in Brazil, by Power, 1980 to 2008 (1980=100)



Source: ANFAVEA (2009). Elaborated by the authors.

According to Graphic 3, it is clear that the demand for tractors did not grow homogeneously. Higher power tractors (power higher than 200HP) are still the most important. This group's high fluctuation of sales is related to the investments in R&D, focused on large scale production. The demand for tractors was also impacted by the monetary stability, from *Real Plan* on, and by two federal credit programs for investment in large farms – Finame, in 1990, and Moderfrota, in 2000.

Regarding to *biofuel demand* – the second diamond set – there is no free market for this product in Brazil. It means that the government coordinates not only the supply, through production, distribution and price, but also the demand, through fiscal incentives and payment facilities to purchase new cars. However, the federal government adopts this policy because fuel, as well as other kinds of energy, is a strategic area for the country. Not by chance, both public credit policies, indicated at Graphic 3 (above), started when the conflicts in the Middle East – Gulf War, Iraq War, etc. – became part of a global

uncertainly, increasing substantially the petroleum price. Hence, the demand for biofuel does not encourage competition among firms participating in the different stages of production, as it happens with other products in domestic market. But the current success of the biofuel policy came also about by the repressed demand – still from the inflation period. Under this circumstance, one can apply the Porter's theory of competitive advantage to the vehicle industry, which creates innovation and quality for the Brazilian and the international markets.

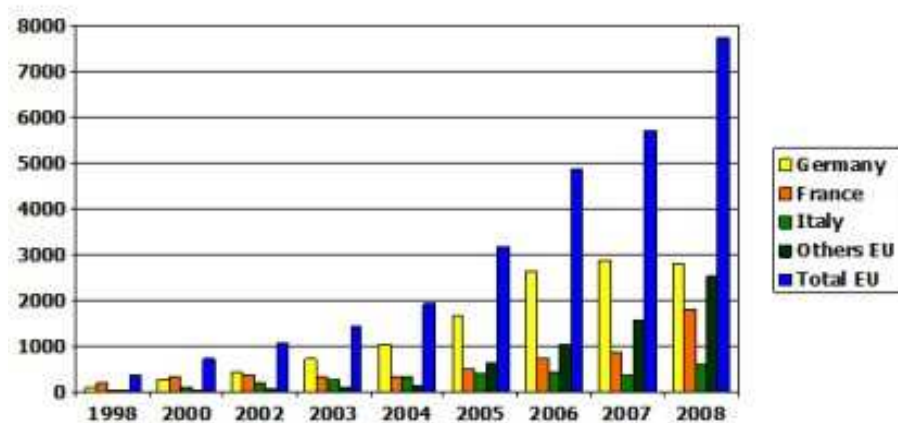
About the third set of Porter's *national diamond*, the *supporting industries*, during the crop 2007/2008, Brazil had 423 industrial complexes. Of this amount, 59% were mills with annexed distilleries, which produce sugar and alcohol; 37% were independent distilleries, i.e. distilleries which produce only alcohol; and 4% were distilleries exclusively for sugar.¹³ The Brazilian mills work, on average, with 80% of self production of raw material from their own land and from leasehold lands. The remaining 20% is supplied by around sixty thousand independent producers with an exclusive contract with smaller mills (BNDES & CGEE, 2008). Thus, one recognizes that most of the mills keep the productive structure of *Proálcool*. The mills control all stages of production of biofuel: planting, harvest, sugarcane processing and extraction of the final product. Currently, some firms reduced their industrial parks, driven by the high cost-opportunity of fix capital, particularly in relation to the price of land. But they represent a small group.

Other important characteristic highlighted by Porter about the *supporting industries* is the development of clusters. As we already pointed out, the spatial distribution of the Brazilian biofuel production is concentrated in Center-South region, especially in São Paulo. In this state, there are excellent conditions of soil and climate, an adequate infrastructure for transport, proximity to consumer markets, facilities to export and an active base of scientific and technological development. All these features are vital to have a kind of competitive advantage, even for the biofuel market still strongly government supported.

The government's influence also does not reduce the last set of Porter's theory: *strategy, structure and rivalry*. At the international market, these are three points to be followed by this sector, if the Brazilian biofuel market wants to stand out. Brazil was the pioneer in creating the biofuel technology, and is known worldwide for its current flexfuel adoption at the national level. However, other nations, that develop similar policies, are already consolidated at the international market. This is the case of Germany, Italy, France and the United States, where the production on an industrial scale began in the early 1990s. Currently the European Union is the main biofuel producer in the world, led by Germany (see Graphic 4). Still, the global market for biodiesel is expected to grow very rapidly over the next decade. In terms of consumption, nowadays Europe represents 80% of global biodiesel consumption, but other countries such as U.S. and Brazil are expected to pass over Europe by 2015. Table 1 shows the features of the biofuel production in these nations.

¹³A list with all Brazilian mills is available at http://www.agricultura.gov.br/pls/portal/docs/PAGE/MAPA/SERVICOS/USINAS_DESTILARIAS/USINAS_CAD_ASTRADAS/UPS_04-08-2009_0_1.PDF.

Graphic 4
EU and Member States' Biodiesel Production



Source: European Biodiesel Board (2009).

Table 1
Some features of the Biofuel Production in the World

Nation	Tax Policy	Type of Biofuel*	Raw Material
Germany	Total	B100 at the gas stations and BS	Colza
Italy	Partial (until 200 thousand ton/year)	B100 for industries and heatings; and B25 for transport	Colza and Sunflower
France	Partial (until 317 thousand ton/year)	More than 50% of the national diesel has 5% biofuel	Colza and Sunflower
United States	Federal incentives and specific rate of each state	B20 is the most popular; in some states is mandatory to use B2; and B100 is rare	Soybeans

Source: BIODIESELBR (2009).

* The type of biofuel refers to the “B” system, which labels fuels according to their biofuel concentration. For example, B20 is a mixture of fuel with 20% biofuel, and B100 is a pure biofuel.

For over a decade, the European Union has been supporting the production and use of biofuel via several strategies and action plans. The European Commission has set aggressive targets for saving of energy consumption and GHG emission, promotion of renewable and biofuel. For example, having at least a 20 % share of energy from renewable sources in the Community’s gross final consumption of energy in 2020, and increasing the use of biofuel in the coming years with the obligation for each Member State to have 10% biofuel in their transport fuel mix by 2020 (European Commission, 2009). Further policy changes might intervene in the future years, which might lead to a modification of the targets set. The main problem is: it will make these countries more dependent on imports and, therefore, more vulnerable, including a likely growth on food domestic prices. Thus, Brazil can take competitive advantage of that, increasing its exports by setting a strategic schedule for the following years.

5. Conclusions

The purpose of this paper was to analyze the Brazilian biofuel chain, focusing on its development, competitiveness and sustainability. According to Porter's theory, a nation can reach a competitive performance through four pillars: *factor conditions*, *demand conditions*, *related and support industries*, and *firm strategy, structure and rivalry*. In the Brazilian case, although some agents are private, the market is coordinated by the federal government, with a policy aimed to increase the domestic demand – which is large and still growing. It means that the biofuel chain does not hit high levels of domestic rivalry, like other sectors in Brazil. However, the biofuel program is successful.

Among the Porter's national diamond dimensions, the most important ones for the Brazilian biofuel chain are *factor conditions* and *strategy*. Brazil has not only climate, topography, land fertility and labor, but also a long tradition in adopting this technology. Since 1975, the federal government supports R&D in partnership with private agents. Because of that, the biofuel chain increased productivity for years, and nowadays, even with the growth of demand – based on the flexfuel technology –, the Brazilian biofuel supply is self-support. Therefore, as Porter pointed out, when the domestic demand is attended, the international market is a goal for new upgrading.

The main conclusion of this paper is that the government's coordination has been crucial for the success of this program. In addition, unlike other nations, Brazil still has the possibility to increase his production – either through harvest area or through productivity – without environmental damage. Thus, Brazil could increase its exportation to nations – which already set biofuel policies – with relative competitive advantage. Finally, the study results show that, in a medium-term, the biofuel export growth cannot affect fuel prices in domestic market and food prices, in general, bringing another competitive advantage on the international market.

References

- ASSOCIAÇÃO NACIONAL DOS FABRICANTES DE VEÍCULOS AUTOMOTORES. *Estatísticas*. Available in: <<http://www.anfavea.com.br>>. Accessible at: Jul. 20th, 2009.
- AZAR, C.; LARSON, E.C. Bioenergy and land-use competition in Northeast Brazil. Available in: <<http://www.princeton.edu/pei/energy/publications/texts/Azar-00-ESD;Biomass-land-use-NE-Brazil.pdf>>. Accessible at: Jul. 28th, 2009.
- BIODIESELBR. *Mapa do biodiesel 2009*. Available in: <<http://www.biodieselbr.com/biodiesel/biodiesel.htm>>. Accessible at: Aug. 3rd, 2009.
- BANCO NACIONAL DE DESENVOLVIMENTO ECONÔMICO SOCIAL and CENTRO DE GESTÃO E ESTUDOS ESTRATÉGICOS. *Bioetanol de cana-de-açúcar: energia para o desenvolvimento sustentável*. Rio de Janeiro: BNDES 2008. 314 p.
- BRANDÃO, A.S.P.; REZENDE, G.C.; MARQUES, R.W.C. *Agricultural growth in the period 1999-2004: outburst in soybeans area and environmental impacts in Brazil*. Rio de Janeiro: IPEA, Discussion Paper 1062, 2005.
- DATAGRO. *Anuário estatístico Datagro*. Available in: <http://www.datagro.com.br/anuario_pt>. Accessible at: Jun. 29th, 2009.
- EMERGING MARKETS ONLINE. BIODIESEL 2020: Global Market Survey, Feedstock Trends and Forecasts - Multi-Client Study, 2nd Edition (2008).
- EUROPEAN COMMISSION. *Communication from the Commission: an EU strategy for biofuels*. Available in: <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0034:FIN:EN:PDF>>. Accessible at: Jan. 1st, 2009.
- EUROPEAN COMMISSION. *Communication from the Commission to the Council and the European Parliament: renewable energy road map, renewable energies in the 21st century: building a more sustainable future*. Available in: <[13](http://eur-</p></div><div data-bbox=)

lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0848:FIN:EN:PDF>. Accessible at: Jan. 1st, 2009.

EUROPEAN UNION. DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

CHO, D.; MOON, H. *From Adam Smith to Michael Porter: evolution of competitiveness theory*. London: World Scientific Publishing Company, 2000. 244 p.

GRANT, M.R. Porter's 'Competitive advantage of nations': an assessment. *Strategic Management Journal*, Malden, v.12, n.7, p. 535-548, Oct. 1991.

GUILHOTO, J.J.; BARROS, A.L.M.; MARJOTTA-MAISTRO, M.C.; ISTAKE, M. *Mechanization process of the sugar cane harvest and its direct and indirect impact over the employment in Brazil and its 5 macro regions*. São Paulo: IPE-USP, Text of Seminars n. 09/2002, 2002.

JOHANSSON, D.J.A.; AZAR, C. A scenario based analysis of land competition between food and bioenergy production in the US. *Journal of Climatic Change*, Stanford, v. 82, p.267-291, 2007.

MARJOTTA-MAISTRO, M.C.; ASSAI, G.A. *Álcool combustível: do carro a álcool ao carro flex*. Piracicaba: CEPEA, 2006. Available in: <http://www.cepea.esalq.usp.br/pdf/Cepea_artigo_flex.pdf>. Accessible at: Mar. 17th, 2009.

MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO. *Mistura carburante: álcool anidro e gasolina*. Available in: <http://www.agricultura.gov.br/pls/portal/docs/PAGE/MAPA/SERVICOS/USINAS_DESTILARIAS/MISTURA_CARBURANTE/MISTURA_COMBUST%CDVEL_25%25.PDF>. Accessible at: Ago. 4th, 2009.

MORAES, M.A.F.D. *A desregulamentação do setor sucroalcooleiro do Brasil*. Americana: Coleção CEPEA, Caminho Editorial, 2000. 238 p.

O'MALLEY, E.; VAN EGERAAT, C. Industry clusters and Irish indigenous manufacturing: limits of the Porter view. *The Economic and Social Review*, Dublin, v. 31, n.1, p. 55-79, 2000.

PORTER, M.E. *On competition*: updated and expanded edition. Boston: Harvard Business School Press, 2008. 576 p.

PORTER, M.E. *The competitive advantage of nations*. London: Palgrave Macmillan, 1990. 896 p.

SILVEIRA, A.M. *A relação entre os preços de açúcar nos mercados domésticos e internacional*. 2004. 74 p. M.S. Thesis, University of São Paulo, Piracicaba, 2004.

UNIÃO DA INDÚSTRIA DA CANA-DE-AÇÚCAR. *Dados e cotações*: estatísticas. Available in: <<http://www.unica.com.br/>>. Accessible at: Jul.29th, 2009.

VAN THUIJL, E.; DEURWAARDER, E.P. *European biofuel policies in retrospect*. Available in: <<http://www.ecn.nl/docs/library/report/2006/c06016.pdf>>. Accessible at: Jul. 20th, 2009.

Annex I
Blend of Gas Adopted in Brazil

Publication of Law	Blend on Gas (%)	Location (States/Regions)
07.01.1976	10-11	PE
07.02.1976	11-12	SP
10.04.1976	11-15	PE/AL
01.07.1977	10-15	PR
05.19.1977	11-13	SP
06.06.1977	10-12	RJ
07.21.1977	10-12	PR
08.03.1977	10-12	CE
09.21.1977	18-20	RN/PB/PE/AL
10.20.1977	18-20	SP (North) / MG (South)
02.03.1978	20-23	NE
04.25.1978	23-25	CE/RN/PB/PE/AL
07.26.1978	20	Center-South
09.05.1978	20	N/NE
04.22.1981	12	N/NE
06.30.1981	12	Center-South
09.28.1981	12	Brazil
12.17.1981	15	
01.05.1982	20	
05.18.1982	20	Center-South
06.15.1983	20	Brazil
06.20.1984	22	
03.13.1989	18	
08.07.1989	22	SP (metropolitan area)
09.04.1989	13	Brazil (except metropolitan area of São Paulo)
11.16.1989	13	Brazil
06.12.1990	22	SP (metropolitan area)
09.25.1992	22	Brazil
10.28.1993	22	
05.28.1998	22-24	
06.15.1998	24	
08.07.2000	20-24	
08.20.2000	20	
05.31.2001	22	
01.10.2002	24	
05.27.2002	20-25	
07.01.2002	25	
02.01.2003	20	
06.01.2003	25	
10.14.2005	20	Manaus-AM
03.01.2006	20	Brazil
11.20.2006	23	
07.01.2007	25	

Source: MAPA (2009).